

## Structural efficiency as digital metaphor: Lightweight interventions in Italy’s first Bitcoin hub

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### Abstract

This paper documents three lightweight interventions within the adaptive reuse of a four-story commercial building in Turin’s city center, transformed into Italy’s first Bitcoin hub. Each installation functions simultaneously as an engineered structural solution and as a spatial translation of blockchain network principles into built form. The first intervention is a tensegrity-based lighting installation for the basement auditorium: this assembly demonstrates distributed load paths where discontinuous compression struts achieve stability through a continuous prestressed cable network, serving dual roles as structural system and spatial illumination, mirroring blockchain’s decentralized consensus topology. The second is a steel cable net structure supporting wooden ceiling panels that translates Bitcoin’s mempool data visualization into built form; this pre-stressed system creates a three-dimensional representation of pending transaction flows, with the cable net’s inherent flexibility allowing for future reconfiguration, reflecting the mempool’s constant state of flux. The third reimagines commercial display through an inflated stainless steel merchandising rack for Bitcoin-related products: this pneumatic structure employs air pressure to achieve rigidity, integrating LED lighting and embedded dual screens within the structural system, reducing material consumption while creating distinctive formal qualities that facilitate public engagement and educational outreach. The paper presents material selection, connection detailing, and fabrication strategies for each intervention, examining how three distinct typologies—tensegrity, cable net, and pneumatic structures—demonstrate unique load-bearing strategies while maintaining visual transparency and efficiency aligned with collaborative workspace requirements. These installations demonstrate that advanced structural systems can transcend technical applications to become communicative architectural devices, and the project proposes that lightweight structures offer unique potential for digital economy infrastructures, where structural innovation serves simultaneously as engineering solution, spatial organizer, and public educator—suggesting new directions for commercial interiors balancing functional performance with conceptual ambition.

**Keywords:** tensegrity lighting, cable net structures, pneumatic structures, structural efficiency

### 1. Introduction

The design of environments dedicated to emerging digital technologies presents a distinctive architectural challenge. Unlike the server farms and data centres that constitute the physical infrastructure of distributed computing, spaces intended to communicate and popularise blockchain technology must mediate between the highly abstract logic of decentralised systems and the embodied, tactile experience of the built environment. Architecture’s traditional instruments—programme, material, structure, light—must be mobilised not only to accommodate use but to make ideas legible.

Blox Space, inaugurated in Turin in 2026 at Via Pietro Micca 21, is conceived as Europe’s first dedicated Bitcoin hub: a mixed-use cultural and commercial environment combining an auditorium, exhibition

areas, a retail zone for Bitcoin-related products, and collaborative workspaces. The project brief required not only functional planning but a spatial identity capable of communicating the intellectual premises of decentralised digital infrastructure—principles such as trustlessness, distributed consensus, transparency, and systemic resilience—to an audience that ranges from technical specialists to the general public.

The design strategy centred on the deployment of lightweight structural systems as the primary vehicles of spatial and conceptual identity. Three discrete interventions were developed, each addressing a different zone of the space and engaging with a different principle of lightweight structural mechanics: tensegrity, cable net prestress, and pneumatic rigidity. This paper documents each intervention through its structural rationale, material specification, and conceptual ambition, proposing that these structural logics constitute genuine isomorphs for blockchain principles—systems whose properties emerge through mechanisms homologous with the distributed logic of digital consensus networks.

## **2. Conceptual framework: Structural efficiency as digital metaphor**

The notion of structural efficiency has historically been defined in material and geometric terms: a structure is efficient insofar as it achieves its load-bearing function with minimal material consumption, directing forces along optimal paths and exploiting the tensile and compressive capacities of its components to their fullest extent [1]. Lightweight structural systems—tensegrity assemblies, cable nets, membranes, pneumatic structures—represent the extreme development of this logic, achieving spatial enclosure and structural stability through the organisation of forces rather than the accumulation of mass.

Blockchain technology, and Bitcoin in particular, operates according to an analogous logic of systemic efficiency achieved through distributed organisation. Rather than concentrating computational authority in a central node—as a conventional monolithic structure concentrates load in a central support—a blockchain distributes the function of verification and record-keeping across a network of independent participants whose collective agreement constitutes the system’s integrity [2]. The stability of the network, like the stability of a tensegrity, is a property of the whole that cannot be located in any individual component.

This parallel informed the design strategy from the outset: each intervention was developed through a process in which the structural system and its digital referent were evolved simultaneously, so that structural rationale and conceptual programme reinforce rather than merely illustrate one another.

## **3. Intervention 1—tensegrity lighting installation**

### **3.1. Structural description**

The basement auditorium of Blox Space is equipped with a custom tensegrity assembly that functions simultaneously as the primary structural element of the ceiling composition and as the principal source of spatial illumination. The assembly is constituted by a network of discontinuous compression struts—rigid members that do not make contact with one another at any node—held in spatial equilibrium by a continuous network of prestressed cables. The compression struts are isolated from one another within the tensile web, achieving stability through the system’s global prestress state rather than through any direct compressive path between members [3].

[4] Tensegrity systems, first systematically explored by Buckminster Fuller and developed structurally by Kenneth Snelson and theorised by René Motro and others [3, 4], are characterised by their capacity to achieve three-dimensional spatial stability with minimal material. The absence of continuous compressive paths—the defining topological feature of tensegrity—means that loads are distributed across the entire network of cables rather than channelled through individual members. This load-path distribution is the structural mechanism that the auditorium installation is designed to make spatially legible.

The compression struts in the Blox Space assembly are fabricated in anodised aluminium, selected for its combination of structural efficiency, reflective surface quality, and low self-weight.



Figure 1: Tensegrity lighting installation, basement auditorium, Blox Space, Turin, 2026.

### **3.2. Luminaire integration: Ivela 35 Linear**

The tensegrity lighting installation is realised through a single product: the Ivela 35 Linear Elemento Master, a modular linear luminaire manufactured in Italy. The installation comprises 56 elements organised as 7 rows of 8, each produced to a custom length of 1000 mm — a configurability structurally essential where each compression strut occupies a geometrically unique position in the global equilibrium. Each element consists of a 35 mm diameter anodised aluminium body with a flat opal polycarbonate diffuser. Elements are anchored via the Ivela adjustable suspension kit, providing independent height adjustment at each point and allowing the tensegrity geometry to be tuned during installation. The luminaire operates at 48 V DC SELV, with a power draw of 15 W per element and consumed power of 10 W; the low-voltage specification eliminates protective conduit at the cable-to-strut nodes, substantially simplifying wiring through the tensegrity net.

The bi-emission optical configuration—120° upward and 240° downward—maps directly onto the tensegrity geometry: upward emission renders the cable network legible in section while downward emission provides ambient illumination to the auditorium floor. The diffuser delivers uniform output at 2700 K with a CRI of 90, appropriate for both technical and public-facing events, and the IP20 rating confirms suitability for a permanently dry interior installation.

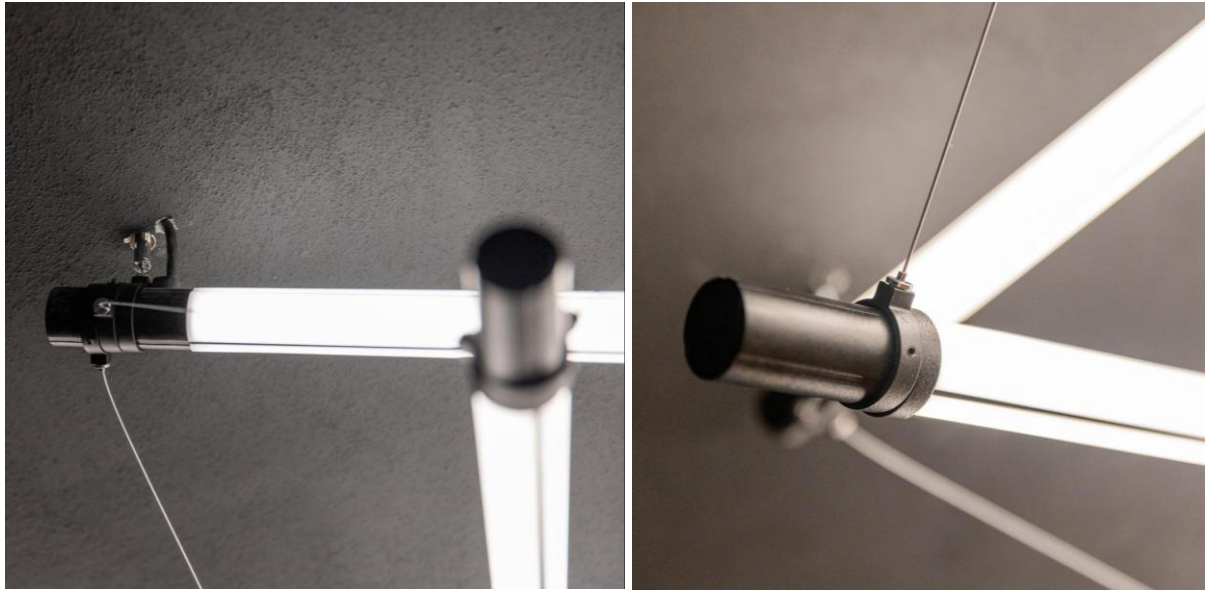


Figure 2: Connection detail — Ivela 35 Linear Elemento Master luminaire integrated within the tensegrity compression strut, Blox Space, Turin, 2026.

Figure 3: Connection detail — the node connector at the cable-to-strut junction

### **3.3. Conceptual dimension: Blockchain consensus topology**

The structural topology of tensegrity is isomorphic with the consensus topology of a blockchain network in a precise and non-trivial sense. In both systems, stability is a global property of the network that cannot be attributed to any individual node or member. In a tensegrity, removing any single cable or strut collapses the system; in a blockchain, the integrity of the ledger depends on the participation of the distributed network of nodes, and no single node constitutes an indispensable centre of authority [2, 5]. Both systems achieve resilience through redundancy of connection rather than through the hierarchy of a central support.

The pretension state of the cable network—the internal stress actively introduced to render the system stable—may be read as a spatial analogue for the computational work that validates each block in a proof-of-work blockchain. Stability, in both cases, is not given but achieved through active energetic investment distributed across the network, a logic made spatially present by the auditorium installation for audiences unfamiliar with either tensegrity mechanics or blockchain consensus.

## **4. Intervention 2—cable net ceiling**

### **4.1. Structural description**

The principal volume of Blox Space is designed to receive a prestressed steel cable net structure supporting a series of timber acoustic panels—an installation currently in progress at the time of writing, scheduled for completion prior to the symposium in September 2026. The cable net is designed to anchor to the perimeter structural frame of the existing building, introducing a controlled system of curvature in plan and section to achieve the anticlastic surface geometry required for structural stability under both gravity and uplift loading conditions [6]. The Jakob Rope Systems cable components, were selected for their precision end-fittings and documented load-test data, which are essential for the verification of the prestress state across the net.

Cable nets are among the most materially efficient structural systems available to the architect. By directing applied loads exclusively through tension in the cable members—exploiting the full tensile

capacity of the steel wire—they minimise the structural material required for a given span [6, 7]. The prestress introduced into the net prior to loading provides geometric stiffness, preventing the load reversals that would otherwise cause slackening of cable members under asymmetric or dynamic loading. The net geometry at Blox Space was developed through iterative form-finding, beginning from a target surface that encoded the conceptual programme described below, and adjusting boundary conditions and prestress levels to satisfy structural performance criteria. The cable network employs stainless steel wire ropes in two diameters: 8 mm for the primary cables running between structural columns, and 5 mm for the transverse cables connecting the net nodes. Pretension adjustment is achieved through 16 M8 wing turnbuckles (FAS Italy, ‘Tenditori con alette’ series, catalogue ref. 0402), which allow independent tensioning at each node following installation and permit fine-tuning of the global prestress state without disassembly of the net.

The timber ceiling panels, designed to be suspended from the net, are to be CNC-cut to individual geometries, creating a continuous and planar ceiling grid. The suspension system is conceived to allow for the future removal and reconfiguration of individual panels without disturbing the structural integrity of the cable net, a flexibility that was a primary design requirement derived from the conceptual programme.

The structural performance of the proposed cable net design was assessed through a finite element analysis conducted in SOFiSTiK [11]. The model comprises approximately 700 discrete cable elements, with boundary conditions defined by the perimeter fixing points at the existing building frame. The analysis examined four load states: the prestressed configuration prior to panel installation, the deformed shape under panel self-weight, the axial force distribution in the final composite state, and the deformation envelope without cladding as a reference condition. Pretension forces across the net range from 0.09 kN in the secondary boundary elements to 8.8 kN in the primary perimeter cables, with the main interior net members carrying prestress forces in the range of 3.5–5.8 kN (Figure 10). The analysis confirmed that the geometry maintains planarity cable tension under all considered load combinations, with no slackening of individual members under asymmetric loading—a critical performance criterion for the reconfigurable panel suspension system. The maximum deflection under full panel load remains within serviceability limits consistent with the acoustic and visual requirements of the space (Figure 11).

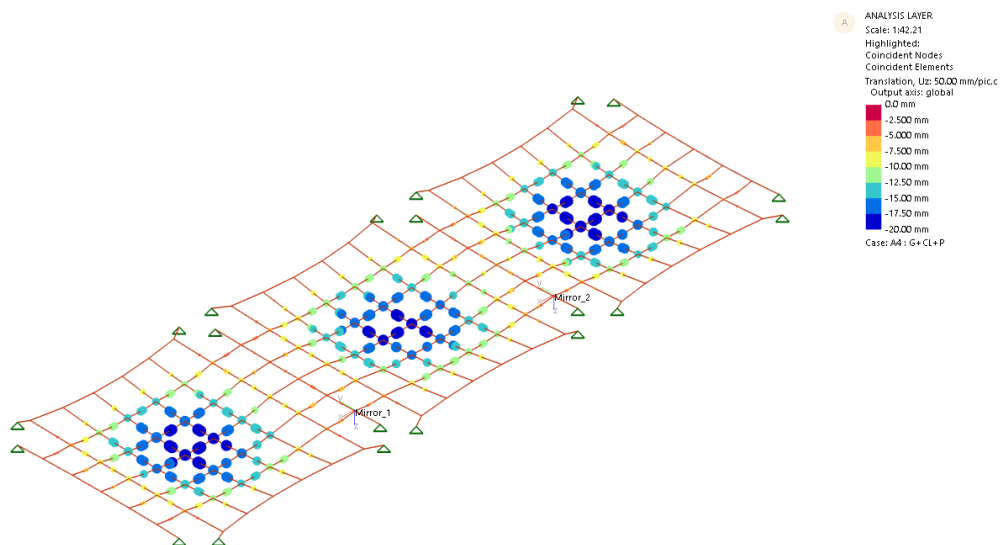


Figure 10: SOFiSTiK finite element analysis — pretension force distribution across the cable net.

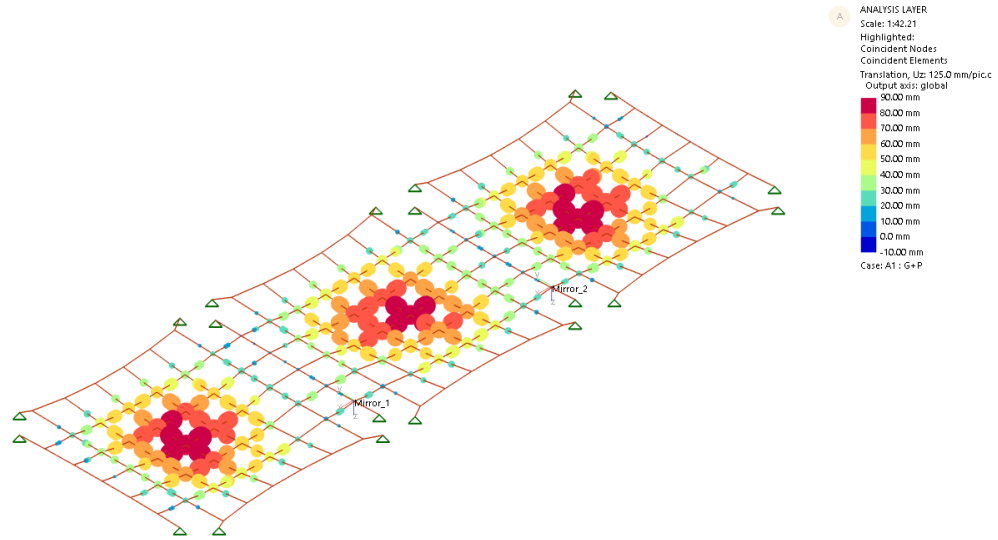


Figure 11: SOFiSTiK finite element analysis — axial force distribution in final state under full panel self-weight.

#### 4.2. Conceptual dimension: The Bitcoin mempool as spatial form

The geometry of the cable net ceiling at Blox Space was directly informed by the visual structure of the Bitcoin mempool—the distributed, temporary repository of unconfirmed transactions awaiting inclusion in a block [2]. The mempool is not a fixed or stable entity: its size, density, and internal organisation fluctuate continuously as new transactions are broadcast to the network and as miners select transactions for inclusion according to their attached fees. Standard mempool visualisation tools represent this dynamic state as a three-dimensional field of nodes of varying size and proximity.

This three-dimensional field provided the generative geometry for the cable net surface: peaks and troughs of the anticlastic net correspond to zones of high and low transaction density in a representative mempool snapshot. The form-finding process—distribution of tension across the net, adjustment of boundary conditions and prestress levels - served as the filter through which mempool data was transformed into a geometrically and structurally coherent surface.

The inherent reconfigurability of the ceiling panel suspension system carries an additional conceptual significance: as the mempool is in a constant state of flux, so the ceiling is designed to be periodically reconfigured to reflect updated mempool states. This capacity for reconfiguration - structurally encoded in the design of the suspension connections - is intended to inscribe the temporal and dynamic character of the mempool into the long-term life of the spatial installation.

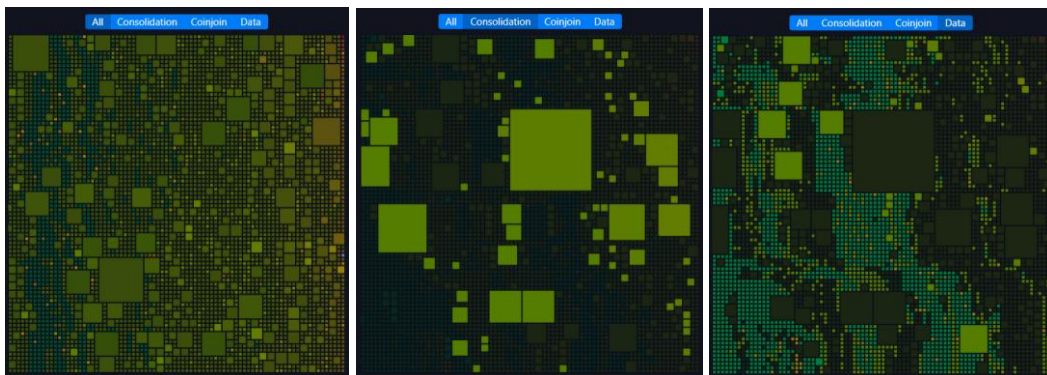


Figure 4, 5 and 6: Bitcoin mempool - All transactions view. Consolidation filter. Data filter (mempool.space).

## **5. Intervention 3—pneumatic stainless steel merchandising rack**

### **5.1. Structural description**

The retail area of Blox Space accommodates a custom merchandising rack for Bitcoin-related products, realised as a pneumatic structure in stainless steel. The rack is composed of inflated tubular stainless steel elements—thin-walled tubes sealed at their ends and pressurised with air—that achieve structural rigidity through the hoop and longitudinal stresses generated by the internal pressure acting on the tube walls [8]. This structural strategy, derived from the principles of pneumatic architecture developed by Frei Otto and others [9], inverts the conventional logic of structural form: rigidity is not achieved by selecting a material of inherent stiffness but by introducing a state of prestress through internal pressurisation.

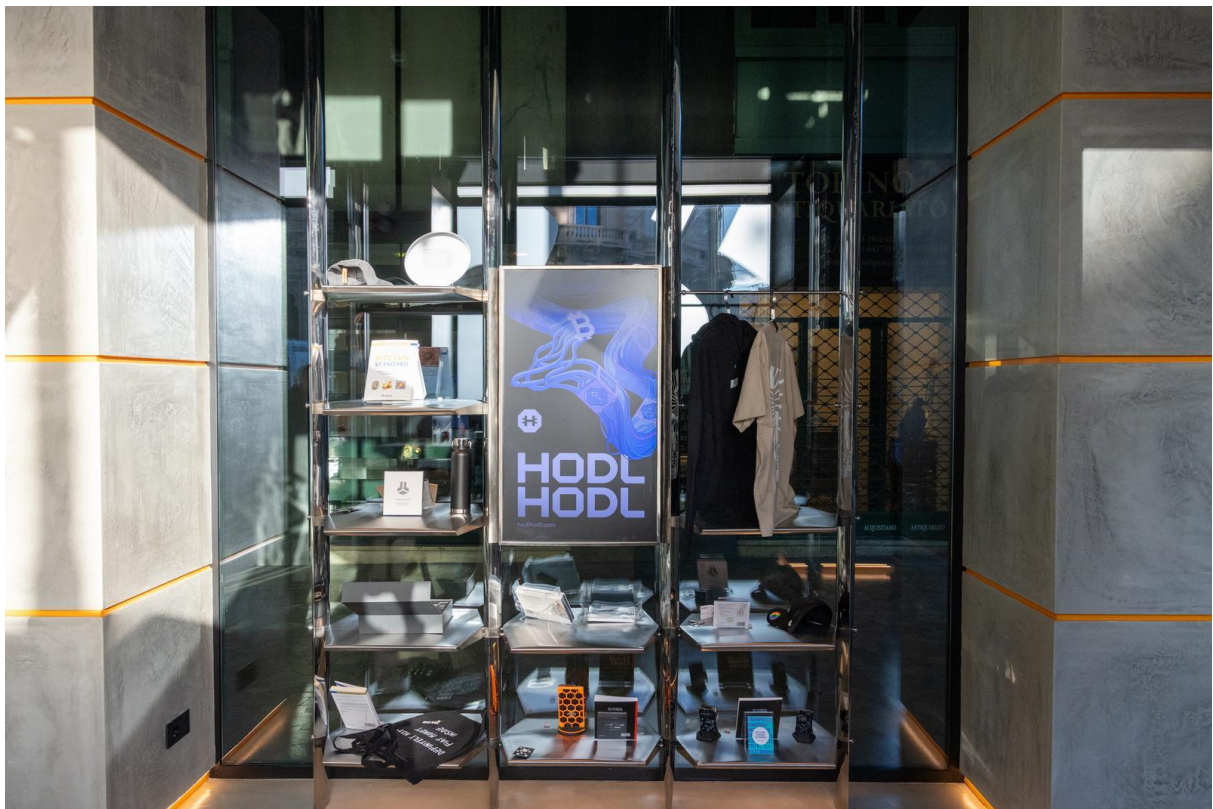


Figure 7: Pneumatic stainless steel merchandising rack, Blox Space, Turin, 2026.

Stainless steel was selected for its structural performance, resistance to repeated handling, and visual quality. The thin wall thickness enabled by pneumatic prestress reduces material volume significantly compared to a conventionally rigid tube of equivalent stiffness, producing a structure that is dematerialised in character and efficient in material consumption. LED lighting elements are integrated within the inflated members, with the pressurised cavity serving as conduit for concealed wiring, and dual embedded screens cantilevered from the structural nodes. Fabrication was carried out by Connor Holland, whose precision metalwork was instrumental in realising the 1 mm thin-wall tube sections, sealed end details, and pressurised node connections.

The structural principles underlying the rack's inflated tube members draw directly on prior research by the author, documented in a preceding IASS paper [12]. The internal pressure, maintained after inflation, functions as a pre-stress that significantly increases collapse strength relative to an uninflated element of equivalent geometry and wall thickness — allowing the elements to be treated as pure compression

members within the structural assembly. In the Blox Space rack, this same principle allows 1mm thin-wall stainless steel tubes to perform as structurally efficient cantilever members under shelf loading conditions, without the material accumulation of conventional structural tube profiles. The rack therefore represents a direct transfer of research findings from a public artwork to a functional commercial installation.

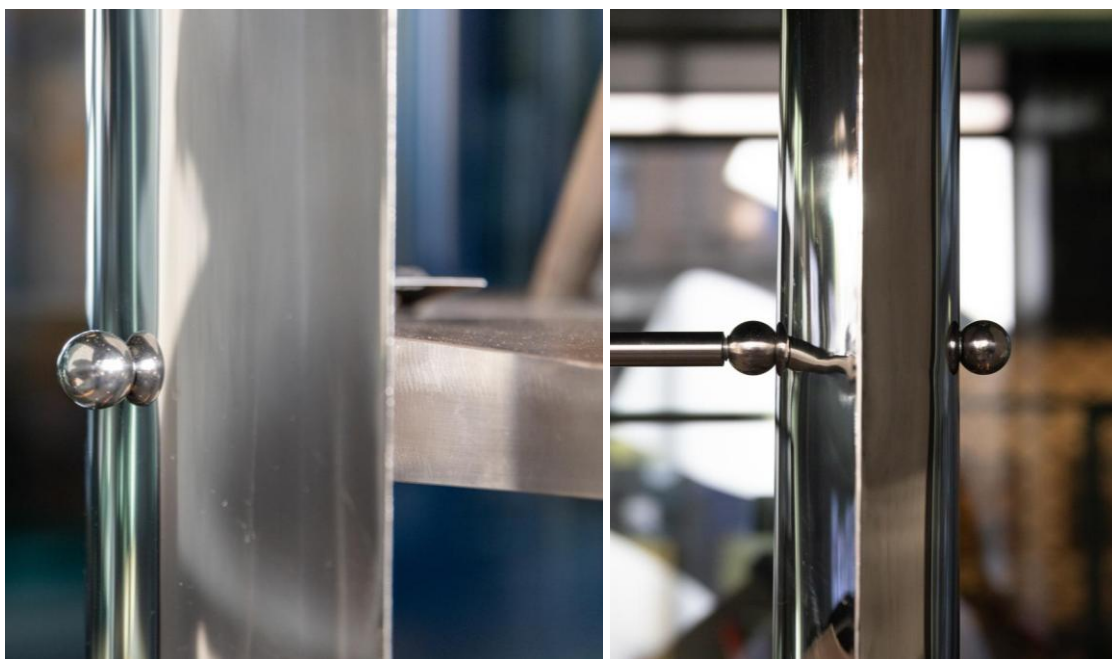


Figure 8: Pneumatic rack with Bitcoin-related merchandise, Blox Space, Turin, 2026.

Figure 9: Connection detail — spherical node at the junction of vertical inflated tube, Blox Space, Turin, 2026.

The rack is designed as a self-contained unit that can be repositioned within the retail area without structural intervention to the host building. Its self-sufficiency—structural, luminous, and informational—enables a high degree of operational flexibility in the configuration of the retail programme.

## **5.2. Conceptual dimension: Decentralised rigidity and educational outreach**

Pneumatic structures achieve rigidity through the action of a gas—a massless medium—distributed uniformly throughout the enclosed volume. No single point within the pressurised member carries more structural responsibility than any other; the rigidity of the whole is the aggregate effect of the uniform pressure acting at every point on the tube wall.

The integration of dual embedded screens within the structural members of the rack transforms the structural element into an educational medium: the screens display real-time blockchain data, transaction visualisations, and explanatory content about Bitcoin's operation, addressing the public engagement and educational outreach dimension of Blox Space's programme. The structural form—lightweight, self-illuminating, informationally rich—serves as an invitation to engagement, presenting technical content within a physical object whose formal qualities communicate accessibility and openness rather than the opacity typically associated with digital infrastructure.

## **6. Discussion**

The three interventions at Blox Space share a common structural logic despite their formal and material diversity. Tensegrity, cable net prestress, and pneumatic rigidity each achieve structural performance through the organisation of internal forces—tension, prestress, pressure—rather than through the accumulation of material mass. In each case, stability is a systemic property: it belongs to the configuration of the whole, not to any individual component considered in isolation. This systemic character is what renders these structural logics genuinely isomorphic—rather than merely analogically similar—to the distributed consensus mechanisms of blockchain technology.

The design process at Blox Space suggests a broader methodological proposition: that the selection of lightweight structural systems on the basis of their systemic logic—rather than solely on the basis of material efficiency, formal preference, or structural performance—opens a productive field of practice in which structural design operates simultaneously as a technical and communicative discipline. Architecture has always communicated through its structural choices, but the emergence of complex, abstract, and publicly consequential digital systems creates a new demand for spatial environments capable of making those systems legible to non-specialist users.

The comparison raises productive questions about the limits of structural metaphor. The isomorphism is one of systemic logic and topological organisation, not of physical mechanism—a tensegrity does not verify transactions; a cable net does not propagate data. This risk was mitigated by the requirement that all structural systems perform genuine, verifiable structural functions, and that the conceptual programme be grounded in technically precise structural principles.

The project situates itself within a longer tradition of enquiry into the communicative potential of lightweight structures—from Frei Otto's explorations of natural structural systems [9] to contemporary research on expressive tensile and pneumatic architecture [10]—extending this tradition into the communication of digital infrastructure.

## **7. Conclusions**

Of the three interventions, two are fully realised at the time of submission: the tensegrity lighting installation and the pneumatic merchandising rack. The cable net ceiling remains in progress, with structural performance verified through finite element analysis in SOFiSTiK [11] and installation scheduled for completion prior to the symposium. The claim for this intervention therefore rests on design intent and analytical verification rather than as-built documentation.

The principal contribution of this work is methodological: lightweight structural systems—selected on the basis of systemic logic rather than material efficiency or formal preference alone—can function simultaneously as engineering solutions, spatial organisers, and communicative architectural devices. The isomorphism between tensegrity, cable net prestress, and pneumatic rigidity on the one hand, and blockchain consensus, mempool dynamics, and decentralised validation on the other, resides in topological and systemic homology, not in visual resemblance.

Future development will address three open questions: the post-installation verification of the cable net's structural performance against the SOFiSTiK model; the potential for the mempool-derived ceiling geometry to be updated as transaction data evolves, activating the reconfigurability embedded in the suspension system design; and the broader question of whether dynamic structural systems—responsive cable nets, actively prestressed assemblies - could engage in real time with the behavioural dynamics of the networks they spatially represent.

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